BISCAYNE NATIONAL PARK FRESHWATER FISH INVENTORY AND MONITORING INTERIM REPORT

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INTRODUCTION

Objectives

This project is intended to fulfill the needs of the NPS Inventory and Monitoring Program for freshwater fishes in Biscayne National Park. The I & M program is a national initiative to document 90% of the species of vertebrates and vascular plants found within NPS properties. This study will also provide useful reference data on the fishes of the southern Miami-Dade County canal system.

Site Description

Biscayne National Park covers an area of 173,000 acres, virtually all of which is shallow subtropical marine habitat (NPS 2004). It also encompasses several offshore islands and a narrow terrestrial fringe along the southern coast of Miami-Dade County. Very little of the park consists of freshwater habitats.

The major freshwater feature in the vicinity of the Park is the Miami-Dade County canal system. Several of these canals empty into Biscayne Bay within the Park or in close proximity to it.

The canals in question are typically several meters deep and have sparsely vegetated, steeply sloping or vertical banks. They have water control structures near the coast to prevent saltwater intrusion and regulate drainage rates. The canals are unlike any naturally occurring freshwater areas found in South Florida (Loftus and Kushlan 1987). They also are often deep enough to penetrate the aquifer, which creates a stable and mild thermal regime even during winter cold fronts (Trexler et al 2001). These facts have probably contributed to the success of introduced species, which are present here in large numbers. Euryhalines also make up a large proportion of the fauna. They are able to enter when the control structures open, and are subsequently trapped in the canal system.

METHODS

Sampling was conducted in the freshwater canal system of Miami-Dade county in the fall of 2002 and again in 2003. A total of six canals were sampled each year: Black Creek, C-100, Florida City, Mowry, Military, and Princeton (Figure 1). We needed to locate our sampling stations on the inland side of the control structures, as the salinity regime on the seaward side is full-strength marine except at times of peak runoff, when the structures are open. Based on their locations, this typically meant that we did not sample within the geographic confines of Biscayne National Park. However, the sampling methodology of this study should give a representative description of the fish populations likely to be present in any freshwater areas of the park

Our primary means of sampling was by performing multiple 100-meter transects along canal banks using a boat electrofisher. The electrofishing data were supplemented with minnow trap sets, visual surveys, and opportunistic cast netting.

For each canal, a one kilometer stretch near the boat access point was divided into 10 100-meter long electrofishing transects. Transects were further subdivided by designating each bank as a separate transect (north vs. south). This created a pool of 20 possible transects for each canal. Five of these were selected randomly for sampling. The same transects were sampled both years wherever possible. A pollution remediation project in Military Canal limited the area that could be sampled in 2003. Shocking was also conducted in an opportunistic fashion when circumstances dictated.

All specimens were identified to the lowest taxonomic level practical. In nearly all cases, identifications were made to species, although this was occasionally not possible, particularly for visual records. The standard and total lengths of each individual were measured and recorded. Most specimens captured were preserved in formalin and retained as vouchers. Exceptions included individuals too large to practically preserve and some members of the most common species.

Physical parameters recorded at each site include salinity, temperature, dissolved oxygen, and pH. Measurements were made using a Hydrolab 4A Surveyor and sonde.

Data were recorded in the field on paper datasheets. Subsequently the paper records were entered into Excel spreadsheets, and then transferred to an Access database for analysis.

RESULTS AND DISCUSSION

A total of 866 individuals of 33 species were captured and positively identified during this study, along with an additional three species recorded visually (Table 1). An unidentified Shad species was also visually detected. The 2002 sampling resulted in the capture of 221 individuals of 18 species, while the 2003 effort produced 645 individuals of 32 species. This disparity is related to the use of a larger, more powerful electroshock craft in C-100 and Black Creek canals in the latter year, as well as to increased familiarity with the sampling techniques among the technicians in 2003. It is unlikely that the observed differences between years are attributable to actual differences in fish populations.

Catch rates ranged from a low of 14 individuals in the Florida City Canal during 2002 to a high of 202 individuals in Military Canal in 2003. Tables 2 through 7 show the catch at each station. Military Canal produced by far the largest total numbers each year, despite having only four transects conducted there each year due to access restrictions in 2003 and mechanical problems in 2002. The reasons for this are unclear, though it may be related to the fact that fishing pressure there is limited relative to the other canals sampled. There are no access points for boats into the canal and it has a reputation for being polluted with wastes from the adjacent Homestead Air Reserve Base, therefore it is not commonly used for fishing. There was also a greater quantity of aquatic vegetation present here relative to the other canals. Apart from the high abundances found in Military Canal, there was little obvious variation in numbers or species composition between sampling sites. Given the general uniformity of the habitat and the interconnectedness of the canal system, this was not unexpected.

Non-native fishes accounted for 10 of the observed species. They also represented 382 of the individuals, or 44 percent of the overall total catch. The most abundant species recorded during this study was the Spotted Tilapia, *Tilapia mariae*. This species has been

observed to be a dominant member of the canal fish fauna in previous studies of the area (Loftus and Kushlan 1987). Other invasive species include Black Acara (*Cichlasoma bimaculatum*), Jewel Cichlid (*Hemichromis letourneauxi*), Mayan Cichlid (*Cichlosoma uropthalmus*), Midas Cichlid (*Amphilophus citrinellum*), Orinoco Sailfin Catfish (*Pterygoplichthys multiradiatus*), Pike Killifish (*Belonesox belizanus*), and Walking Catfish (*Clarias batrachus*). Additionally, two intentionally introduced species were recorded: Grass Carp (*Ctenopharyngodon idella*) and Peacock Bass (*Cichla ocellaris*). The former are a sterile triploid species stocked to control weeds, while the latter have been released to control cichlid populations and to provide recreational fishing opportunities for anglers (Shafland 1996).

Fourteen euryhaline species were taken from the canals. They accounted for 217 individuals. Euryhaline species present in our samples include American Eel (*Anguilla rostrata*), Atlantic Needlefish (*Strongylura marina*), Crested Goby (*Lophogobius cyprinoids*), Crevalle Jack (*Caranx hippos*), Fat Sleeper (*Dormitator maculatus*), Goldspotted Killifish (*Floridichthys carpio*), Gray Snapper (*Lutjanus griseus*), Inland Silverside (*Menidia beryllina*), Largescale Spinycheek Sleeper (*Eleotris amblyopsis*), Rainwater Killifish (*Lucania parva*), Common Snook (*Centropomus undecimalis*), Striped Mullet (*Mugil cephalus*), Tidewater Mojarra (*Eucinostomus harengulus*), and White Mullet (*Mugil curema*).

The remaining species were a subset of the native freshwater fish fauna found in natural aquatic environments in south Florida. Cyprinodontoids and centrarchids dominated. The most common freshwater cyprinodontoid was the Bluefin Killifish (*Lucania goodei*). Sailfin Molly (*Poecilia latipinna*) and Mosquitofish (*Gambusia holbrooki*) occurred frequently, and Golden Topminnow (*Fundulus chrysotus*) were also collected. Centrarchid species included Spotted Sunfish (*Lepomis punctatus*), Redear Sunfish (*Lepomis microlophus*), Bluegill (*Lepomis macrochirus*), Warmouth (*Lepomis gulosus*) and Largemouth Bass (*Micropterus salmoides*). This assemblage of native freshwater species is similar to that found in the area by previous researchers (Loftus and Kushlan 1987). Additional native freshwater species recorded include Bowfin (*Amia calva*), Swamp Darter (*Etheostoma fusiforme*), and Shad (*Dorosoma* spp.).

The best estimates for the total number of freshwater fish species present in the study area ranges from 30 to 80 (see Appendix 1). While our results fall within the lower end of this range, many of these potential species are occasional euryhaline migrants or are rare exotics that have been released into south Florida canals but are not well established. While it is difficult to estimate with certainty what percentage of species established in the area have been recorded here, it is probable that all the dominant members of the local fish fauna have been captured in this study.

LITERATURE CITED

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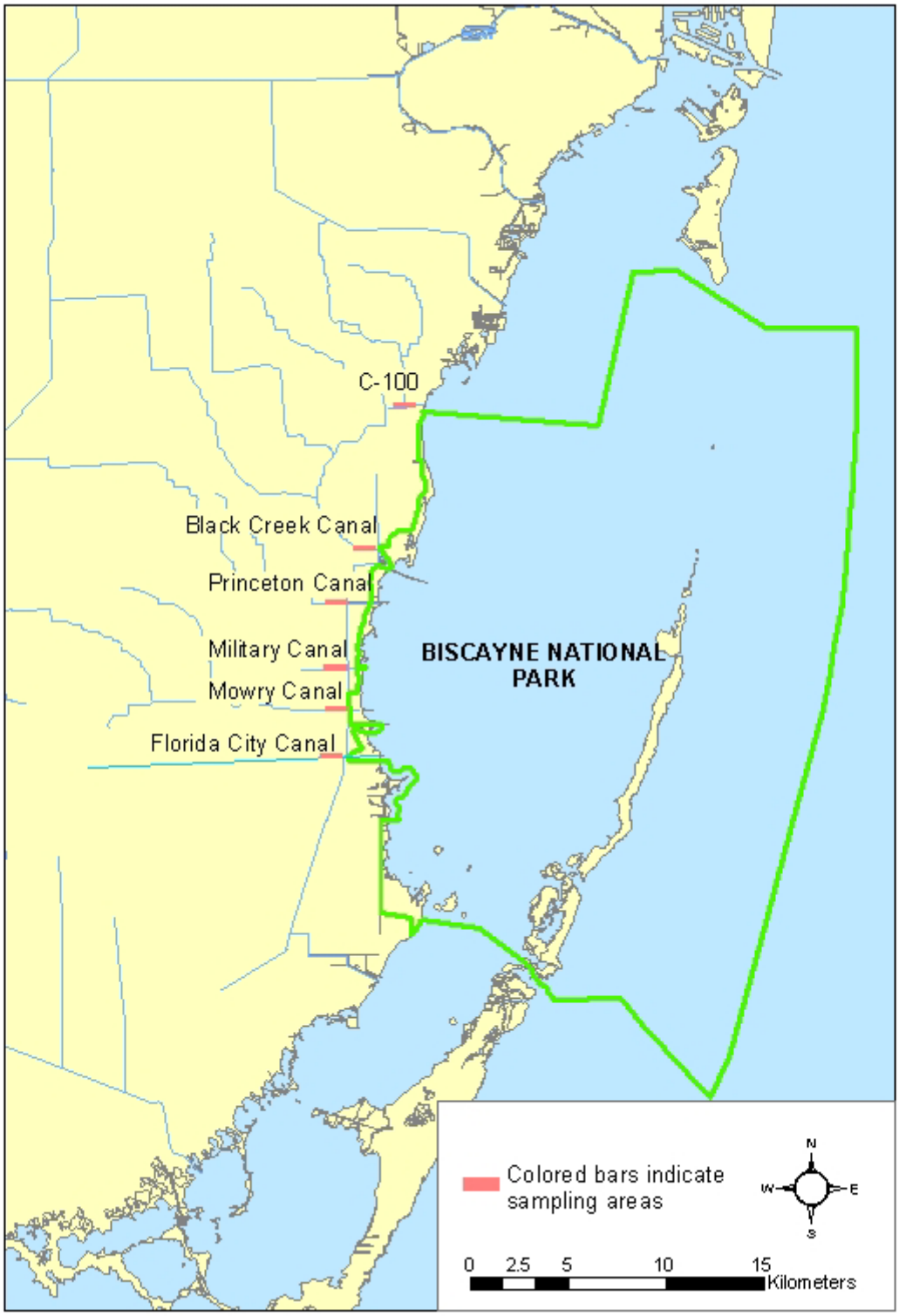

Figure 1: Biscayne National Park freshwater fish I & M sampling locations, 2002-2003

Table 1: BICY I&M overall catch, 2002-2003

species		**2002**	**2003**	**overall**
American Eel	*Anguilla rostrata*	6	16	22
Atlantic Needlefish	*Strongylura marina*	-	1	1
Black Acara	*Cichlasoma bimaculatum*	4	3	7
Bluefin Killifish	*Lucania goodei*	2	107	109
Bluegill	*Lepomis macrochirus*	3	24	27
Bowfin	*Amia calva*	-	1	1
Cichlid spp.	*Cichlasoma* spp.	1	-	1
Crested Goby	*Lophogobius cyprinoides*	39	52	91
Crevalle Jack	*Caranx hippos*	*	*	*
Eastern Mosquitofish	*Gambusia holbrooki*	14	11	25
Fat Sleeper	*Dormitator maculatus*	-	1	1
Golden Topminnow	*Fundulus chrysotus*	-	1	1
Goldspotted Killifish	*Floridichthys carpio*	-	1	1
Grass Carp	*Ctenopharyngodon idella*	*	1	1
Gray Snapper	*Lutjanus griseus*	*	*	*
Inland Silverside	*Menidia beryllina*	-	3	3
Jewel Cichlid	*Hemichromis letourneauxi*	27	49	76
Largemouth Bass	*Micropterus salmoides*	3	3	6
Mayan Cichlid	*Cichlasoma urophthalmus*	11	51	62
Midas Cichlid	*Amphilophus citrinellum*	3	4	7
Mojarra spp.	*Eucinostomus* spp.	18	10	28
Orinoco Sailfin Catfish	*Pterygoplichthys multiradiatus*	2	2	4
Oscar	*Astronotus ocellatus*	-	*	*
Peacock Bass	*Cichla ocellaris*	13	12	25
Pike Killifish	*Belonesox belizanus*	-	4	4
Rainwater Killifish	*Lucania parva*	-	2	2
Redear	*Lepomis microlophus*	5	12	17
Sailfin Molly	*Poecilia latipinna*	14	21	35
Shad spp.	*Dorosoma* spp.	*	-	*
Snook	*Centropomus undecimalis*	-	2	2
Spinycheek Sleeper	*Eleotris amblyopsis*	-	3	3
Spotted Sunfish	*Lepomis punctatus*	10	44	54
Spotted Tilapia	*Tilapia mariae*	35	157	192
Striped Mullet	*Mugil cephalus*	1	27	28
Sunfish spp.	*Lepomis* spp.	1	-	1
Swamp Darter	*Etheostoma fusiforme*	-	4	4
Tidewater Mojarra	*Eucinostomus harengulus*	-	1	1
Walking Catfish	*Clarias batrachus*	-	3	3
Warmouth	*Lepomis gulosus*	9	6	15
White Mullet	*Mugil curema*	-	6	6
total		221	644	865

* denotes visual records only

Table 2: BISC freshwater fish sampling results for Black Creek Canal

2002 results

species		total number	method
American Eel	*Anguilla rostrata*	1	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	1	electrofishing
Peacock Bass	*Cichla ocellaris*	10	electrofishing
Redear	*Lepomis microlophus*	1	electrofishing
Spotted Sunfish	*Lepomis punctatus*	6	electrofishing
Striped Mullet	*Mugil cephalus*	1	electrofishing
Tilapia spp.	*Oreochromis spp.*	-	visual
	total:	20	

2003 results

species		total number	method
American Eel	*Anguilla rostrata*	4	electrofishing
Bluegill	*Lepomis macrochirus*	10	electrofishing
Bowfin	*Amia calva*	1	electrofishing
Fat Sleeper	*Dormitator maculatus*	1	minnow trap
Grass Carp	*Ctenopharyngodon idella*	1	electrofishing
Largemouth Bass	*Micropterus salmoides*	2	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	3	electrofishing
Peacock Bass	*Cichla ocellaris*	11	electrofishing
Redear	*Lepomis microlophus*	6	electrofishing
Snook	*Centropomus undecimalis*	2	electrofishing
Spotted Sunfish	*Lepomis punctatus*	34	electrofishing
Spotted Tilapia	*Tilapia mariae*	5	electrofishing
Striped Mullet	*Mugil cephalus*	27	electrofishing
Warmouth	*Lepomis gulosus*	1	electrofishing
Orinoco Sailfin Catfish	*Pterygoplichthys multiradiatus*	-	visual
	total:	108	
	overall total:	128	

Table 3: BISC freshwater fish sampling results for C-100

2002 results

species		total number	method
Bluegill	*Lepomis macrochirus*	2	electrofishing
Cichlid spp.	*Cichlasoma spp.*	1	electrofishing
Crested Goby	*Lophogobius cyprinoides*	1	electrofishing
Eastern Mosquitofish	*Gambusia holbrooki*	6	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	3	electrofishing
Midas Cichlid	*Amphilophus citrinellum*	3	electrofishing
Peacock Bass	*Cichla ocellaris*	3	electrofishing
Spotted Sunfish	*Lepomis punctatus*	3	electrofishing
Spotted Tilapia	*Tilapia mariae*	7	electrofishing
Warmouth	*Lepomis gulosus*	9	electrofishing
American Eel	*Anguilla rostrata*	-	visual
Grass Carp	*Ctenopharyngodon idella*	-	visual
Largemouth Bass	*Micropterus salmoides*	-	visual
shad spp.	*Dorosoma spp.*	-	visual
	total:	38	

2003 results

species		total number	method
American Eel	*Anguilla rostrata*	4	electrofishing
Bluefin Killifish	*Lucania goodei*	1	electrofishing
Bluegill	*Lepomis macrochirus*	3	electrofishing
Crested Goby	*Lophogobius cyprinoides*	2	electrofishing
Eastern Mosquitofish	*Gambusia holbrooki*	3	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	1	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	1	electrofishing
Midas Cichlid	*Amphilophus citrinellum*	4	electrofishing
Peacock Bass	*Cichla ocellaris*	1	electrofishing
Redear	*Lepomis microlophus*	1	electrofishing
Spotted Tilapia	*Tilapia mariae*	11	electrofishing
Swamp Darter	*Etheostoma fusiforme*	4	electrofishing
Warmouth	*Lepomis gulosus*	4	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	5	minnow trap
Spotted Tilapia	*Tilapia mariae*	2	minnow trap
Grass Carp	*Ctenopharyngodon idella*	-	visual
Largemouth Bass	*Micropterus salmoides*	-	visual
Needlefish spp.	*Strongylura spp.*	-	visual
Orinoco Sailfin Catfish	*Pterygoplichthys multiradiatus*	-	visual
Oscar	*Astronotus ocellatus*	-	visual
Snook spp.	*Centropomus spp.*	-	visual
	total:	47	
	overall total:	85	

Table 4: BISC freshwater fish sampling results for Florida City Canal
2002 results

species		total number	method
American Eel	*Anguilla rostrata*	2	electrofishing
Bluefin Killifish	*Lucania goodei*	1	electrofishing
Crested Goby	*Lophogobius cyprinoides*	7	electrofishing
Eastern Mosquitofish	*Gambusia holbrooki*	2	electrofishing
Largemouth Bass	*Micropterus salmoides*	1	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	1	electrofishing
Crevalle Jack	*Caranx hippos*	-	visual
Gray Snapper	*Lutjanus griseus*	-	visual
Mojarra spp.	*Eucinostomus spp.*	-	visual
Needlefish spp.	*Strongylura spp.*	-	visual
Orinoco Sailfin Catfish	*Pterygoplichthys multiradiatus*	-	visual
Peacock Bass	*Cichla ocellaris*	-	visual
Redear	*Lepomis microlophus*	-	visual
	total:	14	

Table 4 cont.
2003 results

species		total number	method
American Eel	*Anguilla rostrata*	5	electrofishing
Bluefin Killifish	*Lucania goodei*	41	electrofishing
Bluegill	*Lepomis macrochirus*	1	electrofishing
Crested Goby	*Lophogobius cyprinoides*	14	electrofishing
Eastern Mosquitofish	*Gambusia holbrooki*	3	electrofishing
Golden Topminnow	*Fundulus chrysotus*	1	electrofishing
Goldspotted Killifish	*Floridichthys carpio*	1	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	1	electrofishing
Largemouth Bass	*Micropterus salmoides*	1	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	4	electrofishing
Pike Killifish	*Belonesox belizanus*	1	electrofishing
Spotted Sunfish	*Lepomis punctatus*	7	electrofishing
Spotted Tilapia	*Tilapia mariae*	8	electrofishing
Tidewater mojarra	*Eucinostomus harengulus*	1	electrofishing
Walking Catfish	*Clarias batrachus*	2	electrofishing
Spotted Tilapia	*Tilapia mariae*	1	cast net
Sailfin Molly	*Poecilia latipinna*	1	minnow trap
Mayan Cichlid	*Cichlasoma urophthalmus*	2	minnow trap
Spotted Tilapia	*Tilapia mariae*	7	minnow trap
Grass Carp	*Ctenopharyngodon idella*	-	visual
Gray Snapper	*Lutjanus griseus*	-	visual
Inland Silverside	*Menidia beryllina*	-	visual
Needlefish spp.	*Strongylura spp.*	-	visual
Orinoco Sailfin Catfish	*Pterygoplichthys multiradiatus*	-	visual
Redear	*Lepomis microlophus*	-	visual
Striped Mullet	*Mugil cephalus*	-	visual
	total:	102	
	overall total:	116	

Table 5: BISC freshwater fish sampling results for Military Canal
2002 results

species		total number	method
American Eel	*Anguilla rostrata*	3	electrofishing
Bluefin Killifish	*Lucania goodei*	1	electrofishing
Bluegill	*Lepomis macrochirus*	1	electrofishing
Crested Goby	*Lophogobius cyprinoides*	21	electrofishing
Eastern Mosquitofish	*Gambusia holbrooki*	6	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	3	electrofishing
Largemouth Bass	*Micropterus salmoides*	2	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	4	electrofishing
Mojarra spp.	*Eucinostomus spp.*	14	electrofishing
Redear	*Lepomis microlophus*	2	electrofishing
Sailfin Molly	*Poecilia latipinna*	6	electrofishing
Spotted Tilapia	*Tilapia mariae*	22	electrofishing
Sunfish spp.	*Lepomis spp.*	1	electrofishing
Crevalle Jack	*Caranx hippos*	-	visual
Gray Snapper	*Lutjanus griseus*	-	visual
Needlefish spp.	*Strongylura spp.*	-	visual
Striped Mullet	*Mugil cephalus*	-	visual
	total:	86	

Table 5 cont.
2003 results

species		total number	method
American Eel	*Anguilla rostrata*	3	electrofishing
Bluefin Killifish	*Lucania goodei*	19	electrofishing
Bluegill	*Lepomis macrochirus*	7	electrofishing
Crested Goby	*Lophogobius cyprinoides*	2	electrofishing
Eastern Mosquitofish	*Gambusia holbrooki*	1	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	14	electrofishing
Pike Killifish	*Belonesox belizanus*	1	electrofishing
Redear	*Lepomis microlophus*	2	electrofishing
Sailfin Molly	*Poecilia latipinna*	11	electrofishing
Spinycheek Sleeper	*Eleotris amblyopsis*	2	electrofishing
Spotted Tilapia	*Tilapia mariae*	89	electrofishing
Walking Catfish	*Clarias batrachus*	1	electrofishing
Warmouth	*Lepomis gulosus*	1	electrofishing
Atlantic Needlefish	*Strongylura marina*	1	cast net
White Mullet	*Mugil curema*	1	cast net
Bluefin Killifish	*Lucania goodei*	31	minnow trap
Jewel Cichlid	*Hemichromis letourneauxi*	1	minnow trap
Mayan Cichlid	*Cichlasoma urophthalmus*	2	minnow trap
Spotted Tilapia	*Tilapia mariae*	13	minnow trap
Gray Snapper	*Lutjanus griseus*	-	visual
Largemouth Bass	*Micropterus salmoides*	-	visual
Needlefish spp.	*Strongylura spp.*	-	visual
Snook	*Centropomus undecimalis*	-	visual
Striped Mullet	*Mugil cephalus*	-	visual
	total:	202	
	overall total:	288	

Table 6: BISC freshwater fish sampling results for Mowry Canal

2002 results

species		total number	method
Crested Goby	*Lophogobius cyprinoides*	8	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	1	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	2	electrofishing
Orinoco Sailfin Catfish	*Pterygoplichthys multiradiatus*	2	electrofishing
Redear	*Lepomis microlophus*	1	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	10	minnow trap
Sailfin Molly	*Poecilia latipinna*	4	minnow trap
Spotted Tilapia	*Tilapia mariae*	6	minnow trap
American Eel	*Anguilla rostrata*	-	visual
Gray Snapper	*Lutjanus griseus*	-	visual
Largemouth Bass	*Micropterus salmoides*	-	visual
Needlefish spp.	*Strongylura spp.*	-	visual
Peacock Bass	*Cichla ocellaris*	-	visual
	total:	34	

2003 results

species		total number	method
Crested Goby	*Lophogobius cyprinoides*	22	electrofishing
Eastern Mosquitofish	*Gambusia holbrooki*	1	electrofishing
Inland Silverside	*Menidia beryllina*	3	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	13	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	17	electrofishing
Mojarra spp.	*Eucinostomus spp.*	2	electrofishing
Orinoco Sailfin Catfish	*Pterygoplichthys multiradiatus*	2	electrofishing
Rainwater Killifish	*Lucania parva*	2	electrofishing
Sailfin Molly	*Poecilia latipinna*	2	electrofishing
Spotted Tilapia	*Tilapia mariae*	2	electrofishing
White Mullet	*Mugil curema*	5	electrofishing
Bluefin Killifish	*Lucania goodei*	1	minnow trap
Bluegill	*Lepomis macrochirus*	1	minnow trap
Jewel Cichlid	*Hemichromis letourneauxi*	3	minnow trap
Redear	*Lepomis microlophus*	2	minnow trap
Sailfin Molly	*Poecilia latipinna*	3	minnow trap
Spotted Tilapia	*Tilapia mariae*	10	minnow trap
American Eel	*Anguilla rostrata*	-	visual
Gray Snapper	*Lutjanus griseus*	-	visual
Mullet spp.	*Mugil spp.*	-	visual
Peacock Bass	*Cichla ocellaris*	-	visual
	total:	91	
	overall total:	125	

Table 7: BISC freshwater fish sampling results for Mowry Canal

2002 results

species		total number	method
Black Acara	*Cichlasoma bimaculatum*	4	electrofishing
Crested Goby	*Lophogobius cyprinoides*	2	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	10	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	3	electrofishing
Mojarra spp.	*Eucinostomus spp.*	4	electrofishing
Redear	*Lepomis microlophus*	1	electrofishing
Sailfin Molly	*Poecilia latipinna*	4	electrofishing
Spotted Sunfish	*Lepomis punctatus*	1	electrofishing
American Eel	*Anguilla rostrata*	-	visual
	total:	29	

2003 results

species		total number	method
Black Acara	*Cichlasoma bimaculatum*	3	electrofishing
Bluefin Killifish	*Lucania goodei*	14	electrofishing
Bluegill	*Lepomis macrochirus*	2	electrofishing
Crested Goby	*Lophogobius cyprinoides*	12	electrofishing
Eastern Mosquitofish	*Gambusia holbrooki*	3	electrofishing
Jewel Cichlid	*Hemichromis letourneauxi*	25	electrofishing
Mayan Cichlid	*Cichlasoma urophthalmus*	8	electrofishing
Mojarra spp.	*Eucinostomus spp.*	8	electrofishing
Pike Killifish	*Belonesox belizanus*	2	electrofishing
Redear	*Lepomis microlophus*	1	electrofishing
Sailfin Molly	*Poecilia latipinna*	4	electrofishing
Spinycheek Sleeper	*Eleotris amblyopsis*	1	electrofishing
Spotted Sunfish	*Lepomis punctatus*	3	electrofishing
Spotted Tilapia	*Tilapia mariae*	9	electrofishing
Crevalle Jack	*Caranx hippos*	-	visual
Grass Carp	*Ctenopharyngodon idella*	-	visual
Gray Snapper	*Lutjanus griseus*	-	visual
Needlefish spp.	*Strongylura spp.*	-	visual
Peacock Bass	*Cichla ocellaris*	-	visual
Striped Mullet	*Mugil cephalus*	-	visual
Walking Catfish	*Clarias batrachus*	-	visual
	total:	95	
	overall total:	124	

Appendix 1: Potential Fish for Biscayne National Park

5 = Present: Collected or seen in study area and expected to still be present
4 = Likely: Found in nearby areas of similar habitat and likely to be present in study area
3 = Possible: Present in nearby areas and possibly found in study area
2 = Doubtful: Present in south Florida with small possibility of occurrence in study area
1 = Unlikely: Present in south Florida, but not very likely in study area

FMNH = Specimen(s) in Florida Museum of Natural History

family	common name	species	present study	5	4	3	2	1	notes
Lepisosteidae	Florida Gar	*Lepisosteus platyrhincus*		X					1
Amiidae	Bowfin	*Amia calva*	**X**		X				2
Megalopidae	Tarpon	*Megalops atlanticus*			X				2
Elopidae	Ladyfish	*Elops saurus*				X			3
Anguillidae	American Eel	*Anguilla rostrata*	**X**	X					1
Clupeiidae	Gizzard Shad	*Dorosoma cepedianum*			X				2
	Threadfin Shad	*Dorosoma petenense*			X				2
Engraulidae	Bay Anchovy	*Anchoa mitchilli*					X		4
Cyprinidae	Grass Carp	*Ctenopharyngodon idella*	**X**			X			5
	Golden Shiner	*Notemigonus crysoleucas*		X					1
	Taillight Shiner	*Notropis maculatus*		X					1
	Coastal Shiner	*Notropis petersoni*				X			2
Catostomidae	Lake Chubsucker	*Erimyzon sucetta*		X					1
Ictaluridae	Yellow Bullhead	*Ameiurus natalis*		X					1
	Brown Bullhead	*Ameiurus nebulosus*		X					1
	Channel Catfish	*Ictalurus punctatus*				X			6
	Tadpole Madtom	*Noturus gyrinus*					X		7
Clariidae	Walking Catfish	*Clarias batrachus*	**X**	X					1
Ariidae	Hardhead Catfish	*Arius felis*				X			3
	Gafftopsail Catfish	*Bagre marinus*					X		8
Callichthyidae	Brown Hoplo	*Hoplosternum littorale*					X		9
Loricariidae	Suckermouth Catfish	*Hypostomus spp.*				X			10
	Orinoco Sailfin Catfish	*Pterygoplichthys multiradiatus*	**X**	X					11
Esocidae	Redfin Pickerel	*Esox americanus*						X	12
	Chain Pickerel	*Esox niger*					X		13
	Pirate Perch	*Aphredoderus sayanus*					X		14
Atherinidae	Brook Silverside	*Labidesthes sicculus*		X					1
	Inland Silverside	*Menidia beryllina*	**X**		X				2
Apocheilidae	Mangrove Rivulus	*Rivulus marmoratus*					X		15
Fundulidae	Diamond Killifish	*Adinia xenica*				X			3
	Golden Topminnow	*Fundulus chrysotus*	**X**		X				2
	Marsh Killifish	*Fundulus confluentus*			X				2
	Gulf Killifish	*Fundulus grandis*				X			3
	Seminole Killifish	*Fundulus seminolis*				X			3
	Longnose Killifish	*Fundulus similis*				X			8
	Bluefin Killifish	*Lucania goodei*	**X**	X					1
	Rainwater Killifish	*Lucania parva*	**X**			X			3
Poeciliidae	Pike Killifish	*Belonesox belizanus*	**X**	X					1
	Mosquitofish	*Gambusia holbrooki*	**X**	X					1
	Mangrove Gambusia	*Gambusia rhizophorae*				X			16
	Least Killifish	*Heterandria formosa*		X					1
Cyprinodontidae	Sheepshead Minnow	*Cyprinodon variegatus*			X				2
	Goldspotted Killifish	*Floridichthys carpio*	**X**			X			1
	Flagfish	*Jordanella floridae*		X					1

	Sailfin Molly	*Poecilia latipinna*	**X**	X				1
Belonidae	Atlantic Needlefish	*Strongylura marina*	**X**		X			17
	Redfin Needlefish	*Strongylura notata*			X			18
	Timucu	*Strongylura timucu*			X			19
Synbranchidae	Asian Swamp Eel	*Monopterus albus*				X		20
Elassomatidae	Everg. Pgymy Sunfish	*Elassoma evergladei*					X	7
Centropomidae	Swordspine Snook	*Centropomus ensiferus*					X	21
	Common Snook	*Centropomus undecimalis*	**X**		X			2
	Fat Snook	*Centropomus parallelus*				X		22
	Tarpon Snook	*Centropomus pectinatus*				X		23
Centrarchidae	Bluespotted Sunfish	*Enneacanthus gloriosus*				X		2
	Warmouth	*Lepomis gulosus*	**X**	X				1
	Bluegill	*Lepomis macrochirus*	**X**	X				1
	Dollar Sunfish	*Lepomis marginatus*				X		2
	Redear Sunfish	*Lepomis microlophus*	**X**	X				1
	Spotted Sunfish	*Lepomis punctatus*	**X**	X				1
	Largemouth Bass	*Micropterus salmoides*	**X**	X				1
	Black Crappie	*Pomoxis nigromaculatus*			X			2
Percidae	Swamp Darter	*Etheostoma fusiforme*	**X**	X				1
Echeneidae	Sharksucker	*Echeneis naucrates*					X	24
Carangidae	Crevelle Jack	*Caranx hippos*	**X**		X			2
Lutjanidae	Gray Snapper	*Lutjanus griseus*	**X**		X			2
Gerreidae	Striped Mojarra	*Eugerres plumieri*			X			2
	Spotfin Mojarra	*Eucinostomus argenteus*					X	25
	Silver Jenny	*Eucinostomus gula*				X		26
	Tidewater Mojarra	*Eucinostomus harengulus*	**X**		X			27
Sparidae	Sheepshead	*Archosargus probatocephalus*					X	3
	Pinfish	*Lagodon rhomboides*				X		28
Sciaenidae	Red Drum	*Sciaenops ocellatus*					X	3
Cichlidae	Peacock Cichlid	*Cichla ocellaris*	**X**	X				29
	Speckled Peacock Cichlid	*Cichla temensis*					X	30
	Midas Cichlid	*Amphilophus citrinellus*	**X**	X				1
	Oscar	*Astronotus ocellatus*	**X**		X			2
	Black Acara	*Cichlasoma bimaculatum*	**X**	X				1
	Jack Dempsey	*Cichlasoma octofasciatum*					X	31
	Yellowbelly Cichlid	*Cichlasoma salvini*					X	32
	Mayan Cichlid	*Cichlasoma urophthalmus*	**X**	X				33
	Redstriped Eartheater	*Geophagus surinamensis*				X		34
	Jewelfish	*Hemichromis letourneauxi*	**X**		X			2
	Banded Cichlid	*Heros severus*				X		35
	Blue Tilapia	*Oreochromis aureus*			X			2
	Mozambique Tilapia	*Oreochromis mossambicus*		X				1
	Jaguar Guapote	*Parachromis managuense*				X		36
	Firemouth Cichlid	*Thorichthys meeki*					X	37
	Spotted Tilapia	*Tilapia mariae*	**X**	X				1
Mugiliidae	Mountain Mullet	*Agonostomus monticola*				X		2
	Striped Mullet	*Mugil cephalus*	**X**	X				1
	White Mullet	*Mugil curema*	**X**				X	38
Eleotridae	Fat Sleeper	*Dormitator maculatus*	**X**			X		2
	Largescale Spinycheek Sleeper	*Eleotris amblyopsis*	**X**			X		39
	Smallscale Spinycheek Sleeper	*Eleotris perniger*					X	40
	Bigmouth Sleeper	*Gobiomorus dormitor*				X		2
Gobiidae	Frillfin Goby	*Bathygobius soporator*					X	41
	Crested Goby	*Lophogobius cyprinoides*	**X**	X				1

	Naked Goby	*Gobiosoma bosci*					X			3
	Clown Goby	*Microgobius gulosus*					X			3
Achiridae	Lined Sole	*Achirus lineatus*						X		42
	Hogchoker	*Trinectes maculatus*					X			3
		Current Total:	**36**	30	20	30	19	3		

Species known in Biscayne NP Study Area (Column 5) =	30	Low range
Species probably in Biscayne NP Study Area (Columns 5+4) =	50	
Species possible in Biscayne NP Study Area (Columns 5+4+3) =	80	High range

Notes:

1: Present in study area (Loftus & Kushlan 1987).
2: Present in canals near study area (Loftus & Kushlan 1987).
3: Present in ENP (Loftus & Kushlan 1987).
4: Present in ENP (Tabb & Manning 1961, Odum 1971) ** Primarily marine.
5: ** Has been stocked in Dade county freshwater and may be present in study area.
6: Present in ENP (Loftus & Kushlan 1987) ** Few records in south Florida, but has been stocked in Dade county.
7: Present in ENP (Loftus & Kushlan 1987) ** No records from coastal canals.
8: Present in ENP (Loftus & Kushlan 1987) ** Primarily marine.
9: Established in Florida and spreading (Nico http://nas.er.usgs.gov).
10: Present in canals near study area (FMNH; Courtenay et al., 1974) ** Apparently established in Dade canals, but many may be misidentifications of *Pterygoplichthys*.
11: Present in study area (Nico http://nas.er.usgs.gov).
12: Present in ENP (Loftus pers. comm.) ** Few records in south Florida.
13: Present in ENP (Loftus & Kushlan 1987) ** No records from coastal canals.
14: Present in ENP (Loftus pers. comm.) ** Few records in south Florida.
15: Present in ENP (Tabb & Manning 1961) ** Primarily marine.
16: Present in canals near study area (Loftus & Kushlan 1987) ** Primarily marine.
17: Present in ENP (Odum 1971; Tabb et al. 1974; Kushlan & Lodge 1974)
18: Present in ENP (Tabb et al. 1974).
19: Present near study area (Belshe 1961) and ENP (Loftus & Kushlan 1987).
20: Present in canals near study area (Nico 1999) ** Present in C-111 and other canals in Dade county.
21: Present in canals near study area (Rivas 1962) ** Rare in south Florida.
22: Present in canals near study area (Rivas 1962; FMNH) ** Uncommon in south Florida.
23: Present in canals near study area (Rivas 1962) and ENP (Tabb et al. 1974) ** Uncommon in south Florida.
24: Recorded from Florida freshwater (FMNH) ** Primarily marine
25: Present in Florida freshwater (FMNH) ** Primarily marine, *E. harengulus* apparently replaces this species in low salinity waters.
26: Present in ENP (Odum 1971; Tabb et al. 1974; Kushlan & Lodge 1974) ** Primarily marine.
27: ** No local records, but records of E. argenteus in south Florida freshwaters may be this species.
28: Present in canals near study area (Hogg 1976)
29: Stocked in canals in study area by FWC.
30: Stocked in canals in study area by FWC ** Not considered to be established, but some may still be present.
31: Present in canals near study area (Hogg 1976) ** Was collected in C-1, but current status unknown.
32: Present in C-11, Broward County (Shafland 1996) ** Not known outside of this location.
33: Present in study area (Shafland 1995).
34: Present in canals near study area (Metzger & Shafland 1984) ** Considered established in the Snapper Creek Canal C-2.

Notes(cont):

35: Present in canals near study area (Shafland 1995) ** Present and may be established in the Snapper Creek Canal C-2 and other canals.

36: Present in canals near study area (Gestring & Shafland 1996) ** Presently known as far south as C-2 Snapper Creek canal.

37: Present in canals near study area (Hogg 1976; FMNH) ** Apparently only established in a small canal near Miami Airport.

38: Present in Everglades drainage (FMNH) ** Primarily marine.

39: Present near study area (Darcy 1978; FMNH; Pezold & Cage 2002) ** Few records in south Florida, most fish formerly identified as *E. pisonis* actually are *E. amblyopsis*.

40: Present in south Florida (Pezold & Cage 2002) ** Only one Florida record currently identified as *E. perniger*.

41: Present in Florida freshwater (FMNH) ** Primarily marine.

42: Present in ENP (Tabb & Manning 1961; Odum 1971; Kushlan & Lodge 1974; Tabb et al. 1974) ** Primarily marine.